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COMMUNICATION DURING TERRAIN FLIGHT

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March 1975

Final Report

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Safe and efficient terrain flight requires that the copilot or navigator give verbal navigation instructions that allow the pilot to respond quickly and effectively with minimum confusion and head-in-cockpit time. The intracockpit communications of forty-seven Nap-of-the-Earth (NOE) training flights were tape recorded. NOE communication questionnaires were developed and administered to sixty student pilots and seventy-four instructor pilots. Analysis of the tapes and questionnaire data indicated

Block 20. (Continued)

that the crew members were spending 30.1 percent of their time in communication concerning navigation. Analysis of the tape recordings also indicated that new student pilot (SP) flight crews exhibited a greater density of communication ($t = 10.07$, $df = 45$, $p < .05$) than did the SP flight crews that had been flying together. Seventy-seven percent of the IPs indicated that formal navigation communication instructions presented in the classroom would be more desirable than IPs teaching their students individually the navigation terms and techniques that should be used.

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SUMMARY

Safe and efficient terrain flight requires that the copilot or navigator give verbal navigation instructions that allow the pilot to respond quickly and effectively with minimum confusion and head-in-cockpit time. The intracockpit communications of forty-seven Nap-of-the-Earth (NOE) training flights were tape recorded. NOE communication questionnaires were developed and administered to sixty student pilots and seventy-four instructor pilots. Analysis of the tapes and questionnaire data indicated that the crew members were spending 30.1 percent of their time in communication concerning navigation. Analysis of the tape recordings also indicated that new student pilot (SP) flight crews exhibited a greater density of communication ($t = 10.07$, $df = 45$, $p < .05$) than did the SP flight crews that had been flying together. Seventy-seven percent of the IPs indicated that formal navigation communication instructions presented in the classroom would be more desirable than IPs teaching their students individually the navigation terms and techniques that should be used.

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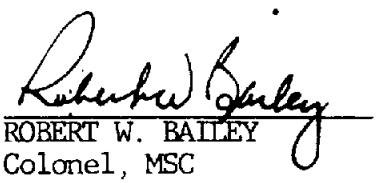

ROBERT W. BAILEY
Colonel, MSC
Commanding

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INTRODUCTION

The unique characteristics of terrain flying, composed of Nap-of-the-Earth (NOE), Low Level and Contour flight levels or techniques, have brought new demands and requirements upon Army helicopter aircrews. One important requirement involves the need to effectively and efficiently transmit navigation information. To effectively transmit such information requires verbal commands from the copilot/navigator to the pilot such that the aircraft can be flown on the desired flight path. To do so efficiently means using terms which are clearly understood, permit maneuvering in a timely manner, and allow the pilot to maintain maximum time outside the cockpit to avoid terrain and obstacles. Even with automatic navigation systems which incorporate head-up displays, substantial intracrew navigation communications will be required for the foreseeable future.

It has been noted that the most significant human factors problem related to NOE flight is the head-in-cockpit time demands made by conventional navigation techniques.[4,5] Safe NOE flight requires that the pilot keep his eyes on immediate obstacles and rely on terrain features and directions from the navigator as the primary means of controlling the direction of his flight. Navigation in this manner is a most difficult task which calls for a great deal of teamwork between the pilot and copilot.[1,4] Cockpit teamwork has emerged as a human factors problem in NOE flight because of the necessity for a division of duties and responsibility among the crew.[1,4] Such factors as physical and mental fatigue resulting from the resolute vigilance required during day and night NOE flight, precipitate a need for a language system which can be relied upon during the most extenuating conditions.

A standardization of terminology to describe the terrain has been suggested,[1,4] but no emphasis has been placed on the standardization of those terms by which the navigator guides the pilot over the terrain. Too often the navigator gives a direction which either requires the pilot to focus inside on the instrument panel for reference or produces some uncertainty in the pilot as to the exact meaning of the instructions. Either case can cause a slower reaction time by the pilot and could result in a degradation in his efficiency in handling the helicopter.

The U. S. Army Agency for Aviation Safety (USAAAVS) recently reviewed the Army aviation accidents occurring between 1958 and 1972 and found that 75-80 percent of the helicopter and fixed wing accidents were listed as having pilot error as one of the cause factors. These pilot error accidents resulted in an average cost of $58,000,000 a year in the form of injuries, fatalities, and aircraft damage.[3] In addition, the report revealed that the proportion of pilot error accidents did not

appreciably change over the fifteen years examined. One would expect, however, that the current emphasis on day and night terrain flight to produce new aviation safety problems.

The USAAAVS accident report indicated that two of the five task errors which contributed to pilot error mishaps were: (1) processing and using information, and (2) communicating. These two task errors could occur in the navigation communication sequence and thus potentially interact with other variables to produce an accident.

A study by Miller, Heise & Lichten (1951) revealed that expectation of certain words improved the recognition of these words.[2] That is, the percentage of orally presented words correctly recognized was inversely related to the size of the vocabulary utilized in the project. Thus, in communications systems, such as those in present day helicopters with high ambient noise levels, the use of a limited and therefore familiar navigation vocabulary should improve intelligibility and reduce confusion and indecision.

At the present time, navigation terminology is not presented formally in the classroom training of rotary wing pilots, however, most of the instructor pilots (IPs) do give informal guidance concerning the terms or phrases that they use. The objective of the current investigation was to examine the navigation terms used by students and IPs during the NOE phase of helicopter tactics training and formulate questionnaires for both instructor and student pilots (who had completed tactics training) in an attempt to determine what navigation terms or phrases were considered to be most efficient and effective.

METHOD

Subjects

NOE Communications Groups. Two groups of IPs and students from the Fort Rucker Department of Undergraduate Flight Training, Advanced Division, were participants in the recording of communication inflight during NOE training (one of the final stages of undergraduate flight training). The first group consisted of five IPs and 10 student pilots (SPs). These SPs had been paired together throughout flight training. The second group consisted of eight IPs and ten SPs (also from the Advanced Division). These ten SPs were switched to new flight partners during the NOE phase of their training.

Questionnaire Respondees

Instructor Pilots. The respondees were 74 IPs from the Department of Undergraduate Flight Training, Advanced Division, Fort Rucker, AL. The IPs' ages ranged from 22 to 47 with a mean age of 28.2. These IPs had total flight hours ranging from 700 to 4100 with a mean of 1933.2.

Student Pilots. The respondees were 60 SPs, tested the last day of their initial rotary wing flight training at Fort Rucker, AL. The SPs' ages ranged from 19 to 37 with a mean age of 25.3. These SPs had total flight hours ranging from 199 to 1985 with a mean of 322.67. Several of the SPs had accumulated a number of flight hours as crewmembers before entering flight training.

Procedure

Phase I, NOE Communication Recording. Tape recorders were connected to the helicopter intercom systems so that all communication occurring inflight was recorded. IPs operated standard battery powered tape recorders during the NOE portion of the SPs' tactical flight training. The NOE block of flight instruction came after the students had completed approximately 33 weeks of their 36 weeks of training.

The IPs turned on the tape recorders at the beginning of each NOE training course and taping was discontinued at the end of the course. During NOE flight training, the IPs sat in the left front seat of the training helicopter (UH-1) while the SPs received six hours of flight training in the right front seat as the pilot and six hours of training in the jump seat as the navigator or copilot. Integrated into these 12 hours of flight were four NOE course runs with each SP acting as the pilot and four runs as the navigator.

In group I, the SPs and IP team integrity was maintained. The SPs who had been partners during early tactics training stayed together during the NOE phase of training, and therefore, were accustomed to flying with each other.

In group II, the SP team was switched such that SPs who had not been together during the early phases of tactics training were partners during the NOE phase of training. Therefore, the new teams of SPs were relatively unfamiliar with each other. Tape recordings of all inflight communication occurring during NOE course runs were obtained by the IPs for training sessions involving both groups.

Phase II, NOE Communication Questionnaire. Information obtained from the recording of the inflight communications of the SPs and IPs of both groups was used to develop a Student Pilot NOE Communication

Questionnaire and an Instructor Pilot NOE Communication Questionnaire. These questionnaires were designed to determine what navigation phrases or terms were used/preferred by SPs and IPs during NOE flight. The questionnaires were given to IPs from three flight branches in group sessions without their students and to SPs, also in group sessions, on their last day of advanced flight training. The respondees were asked to give only their age and total flight hours so that their responses remained anonymous.

RESULTS AND DISCUSSION

Phase I. The tape recordings of the two NOE communication groups were examined for density of communication or percent communication time per total tape (course) time. The results of this examination are shown in Table 1.

Table 1

Comparison of the Communication Groups

	Group I	Group II
Number of NOE Course Runs Taped	21	26
Mean Total Tape (Course) Time in Minutes	38' 20"	32' 18"
Mean Communication Time in Minutes	13' 38"	14' 36"
Mean Percent Communication Time	35.5%	45.2%

The difference in the mean percent communication times for the two groups was examined statistically ($t = 10.07$, $df = 45$, $p < .05$), revealing that there was a significantly greater density of communication exhibited by Group II individuals who were teamed together for the first time during NOE flight training. The relatively greater amount of time spent in communication by the new partner group compared to the old partner group perhaps indicated the need for a greater amount of conversation for navigation with new flight partners, a situation which may be impacted if standardized navigation terms were taught.

Examination of the tapes indicated a frequent use of terms that either were confusing or that required the pilot to refer to his instruments, thus bringing his head inside the cockpit and momentarily off the terrain obstacles immediately ahead of the helicopter. Many of the confusing phrases used for navigation directions were slang terms used by the copilot directing the pilot to change the heading of

the helicopter. The slang jargon used by the copilots often produced some indecision on the part of pilots who were not aware of the meaning the copilots associated with the terms.

Unqualified "turn right" or "turn left" instructions also caused indecision and slower reaction time in completion of the maneuver when the pilot was not sure of the magnitude or degree of turn desired. Some of the student navigators, who sat in the jump seat located slightly to the rear of the pilot's seat, even resorted to the use of hand signals in directing the pilot. A great many examples such as this illustrated the need for an examination of inflight navigation communication in order to determine the techniques considered the most desirable or efficient by IPs and SPs.

Phase II. The following questions and responses are grouped as much as possible according to the general subject matter of the questions. The questions, in some cases paraphrased, will be included with the responses. Statistical comparisons were also reported, where appropriate, when the IP and SP responses significantly differed.

Instructor and Student Pilot NOE Communication Questionnaire Responses.
1. The IPs and SPs were asked to evaluate various NOE navigation communication phrases which are currently being used by students and IPs. Their responses indicated that the most desirable (1) to least desirable (5) phrases were considered to be:

IP Responses:

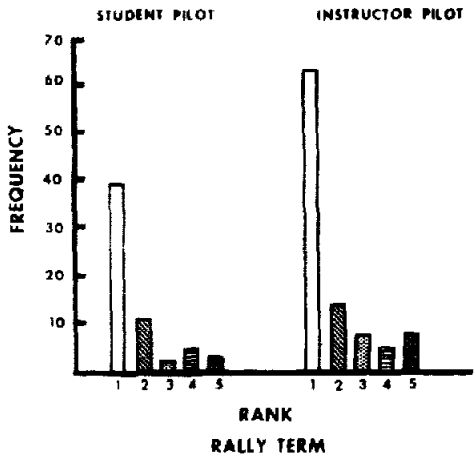
1 - Rally terms, turn left--roll out or stop turn (at the appropriate time).
2 - Clock headings--turn to your 11:00 o'clock.
3 - Turn an estimated number of degrees off straight ahead--turn 20^{o} left.
4 - Turn to an azimuth--turn to a heading of 340^{o}.
5 - Turn to a cardinal magnetic heading--turn to a heading of NNW.

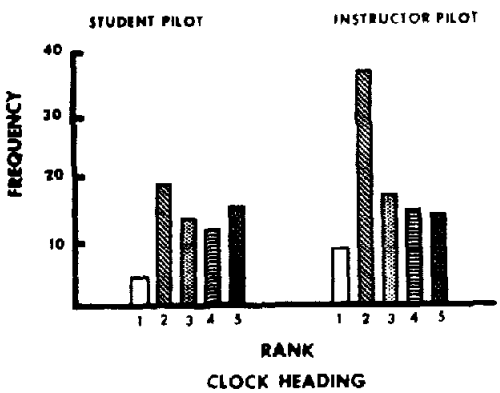
SP Responses:

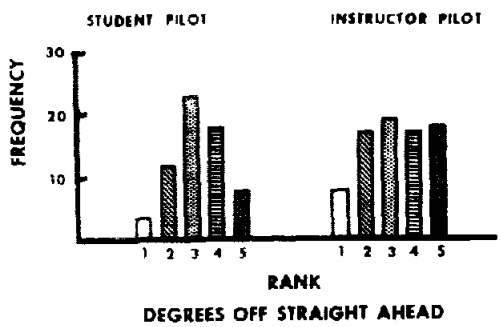
1 - Rally term.
2 - Clock heading, and 3 - Azimuth, very little difference between the preference of the two.
4 - Degrees off straight ahead.
5 - Cardinal magnetic heading.

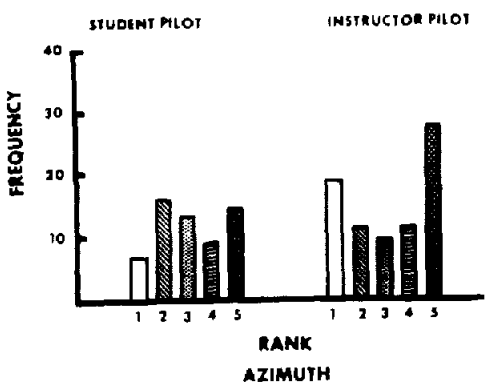
Figure 1 depicts the ranking for each type of navigation instruction.

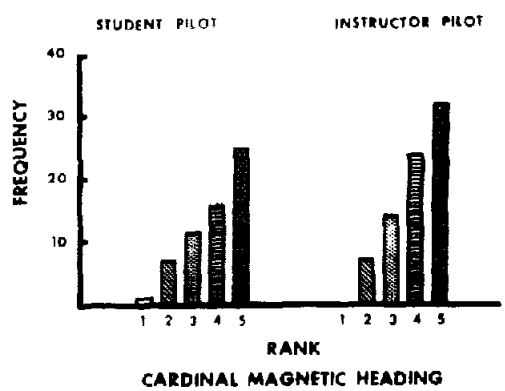
FIGURE 1
SP AND IP RANKINGS OF VARIOUS NOE COMMUNICATION PHRASES OR TECHNIQUES











2. During NOE flight, you are the pilot and copilot gave you the following instructions. Use the rating scale from Question One and rate the responses. Order of ranking:

SP Responses:

1 - Rally terms.
2 - Degrees off straight ahead.
3 - Clock headings.
4 - Cardinal magnetic heading.
5 - Azimuths.

IP Responses:

1 - Rally terms, turn right--roll out or stop turn (at the appropriate time).
2 - Clock headings, turn to your 3:00 o'clock.
3 - Degrees off straight ahead, turn 90° to the right.
4 - Cardinal magnetic heading, turn to the East.
5 - Azimuths, turn to a heading of 090°.

Figure 2 depicts the rankings for each type of navigation instruction.

3. During NOE flight, would you rather follow terrain features such as creek beds or fence lines or would you rather be told to turn left or right by the copilot as required and thus be pointed in the right direction?

	IPs	SPs
a. Follow terrain features	81%	80%
b. Be pointed in the right direction	19%	20%

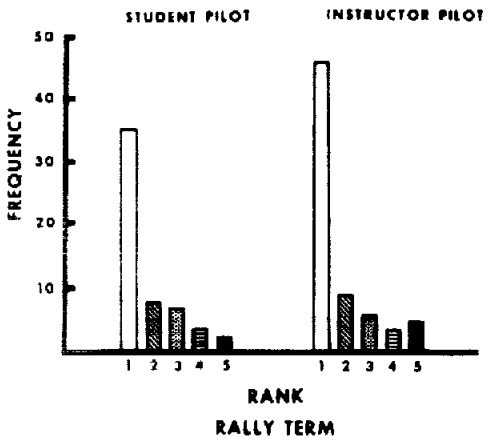
NOTE: Instructor and student pilot comments on Questions 3, 4, 5, 8, 9, 11, 13, 15, 20 and 28 are listed, along with the frequency of expression of each idea, in Appendix A.

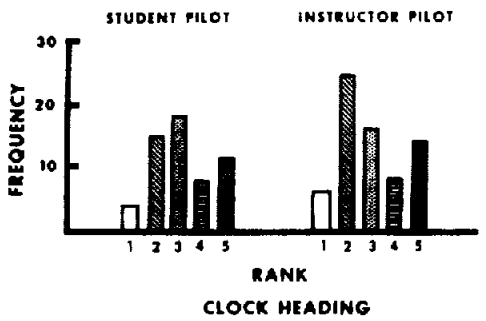
4. During NOE flight would you rather know where you are supposed to fly the helicopter (that is, be given a visual target ahead on the terrain) or would you rather be told to turn left or right as required and thus be pointed in the right direction by the copilot?

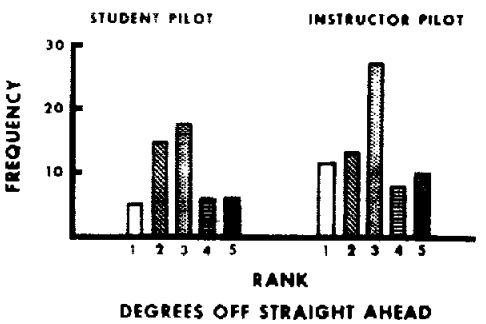
	IPs	SPs
a. Have a visual target	83%	90%
b. Be pointed in the right direction	17%	10%

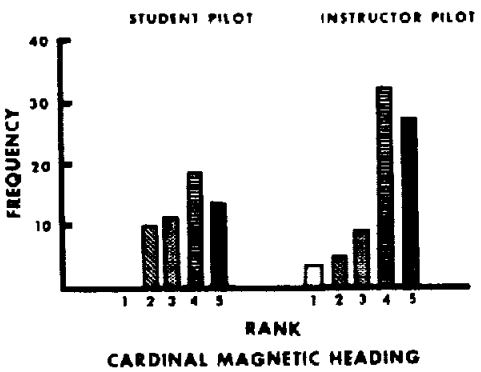
FIGURE 2

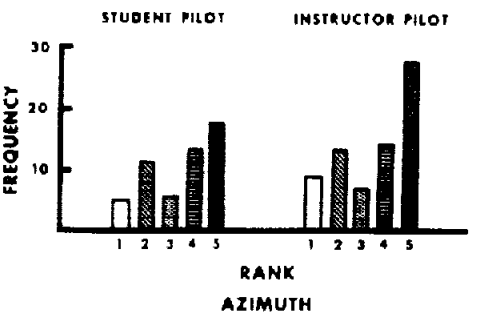
SP AND IP RANKINGS OF VARIOUS NOE NAVIGATION INSTRUCTIONS











5. During NOE flight would you rather follow terrain features such as creek beds and valleys or would you rather have the copilot tell you to turn to your 11:00 o'clock or 1:00 o'clock (clock headings) as required so that you are constantly being pointed in the right direction?

	IPs	SPs
a. Follow terrain features	90%	92%
b. Be pointed in the right direction with clock headings instructions	10%	8%

6. What navigation terms or phrases do you usually use during NOE flight when you are the copilot (for example, clock headings, azimuths, terrain features, rally terms, etc.)? Do you use a combination of these terms?

SPs Responses:

1 - Use whatever it takes to communicate
19 - Best results occur when telling pilot to follow terrain features and using turn-stop-turn directions if he strays from course.
11 - Use terrain features coupled with azimuths
3 - Use a combination of terms, depending upon density and type of terrain
5 - Rally terms
5 - Terrain features
1 - Terminology is not the determining factor, pilot-copilot responsibility to set up system prior to flight
1 - Clock headings, azimuths and rally terms
3 - Terrain points located by clock headings
1 - Terrain features located by clock headings
4 - Terrain, clock headings and azimuths
2 - Terrain, rally terms and azimuths
1 - Terrain and degree turns

IPs Responses:

30 - Combination of the terms
21 - Rally terms and terrain features
6 - Azimuths and terrain features are used more
6 - Clock headings and terrain features
4 - Rally terms
3 - Azimuths, terrain features, rally terms
3 - Terrain features
2 - Rally terms and clock headings

7. During NOE flight, which of the following instructions do you feel could be accomplished faster (with shorter reaction time)? Rate the options from 1 to 5. With 1, accomplished with a very small reaction time; with 5, accomplished with a long reaction time. Order of ranking:

SPs Responses:

1 - Rally terms, turn right--roll out or stop turn (at the appropriate time).
2 - Clock headings, turn to your 2:00 o'clock.
3 - Degrees off straight ahead, turn 45° to the right.
4 - Azimuth, turn to a heading of 045°.
5 - Cardinal magnetic heading, turn to a heading of Northeast.

IPs Responses:

1 - Rally terms, turn right--roll out or stop turn (at the appropriate time).
2 - Clock headings, turn to your 2:00 o'clock.
3 - Degrees off straight ahead, turn 45° to the right.
4 - Cardinal magnetic heading, turn to a heading of Northeast.
5 - Azimuth, turn to a heading of 045°.

Figure 3 depicts the rankings for each type of navigation instructions.

8. During NOE flight would you rather have the copilot give you rally instructions (turn right or left, stop turn, roll out, etc.), or would you rather have the copilot give you clock headings (such as turn to your 2:00 o'clock or turn to your 10:00 o'clock)?

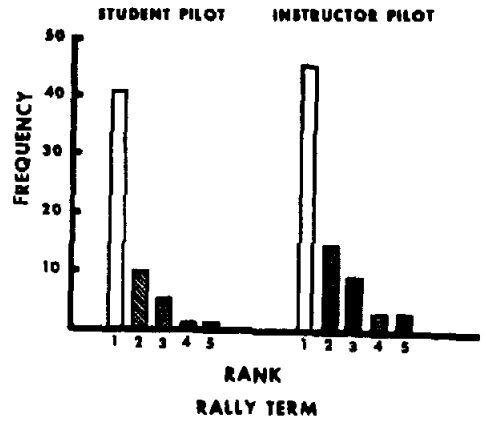
	IPs	SPs
a. Rally instructions	78%	87%
b. Clock headings	22%	13%

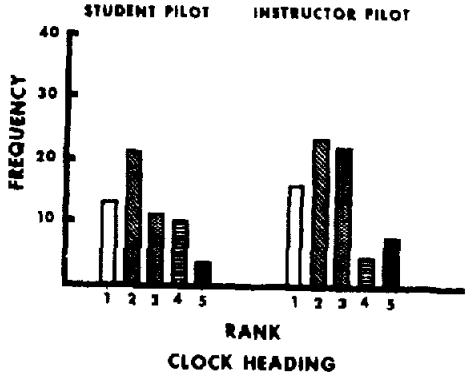
9. Have you ever heard a student pilot use a navigation term or phrase which caused the student pilot to be confused or unsure as to what he was supposed to do?

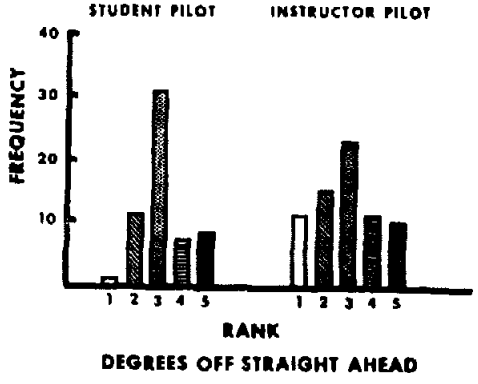
	IPs	SPs
a. Yes	89%	63%
b. No	11%	37%

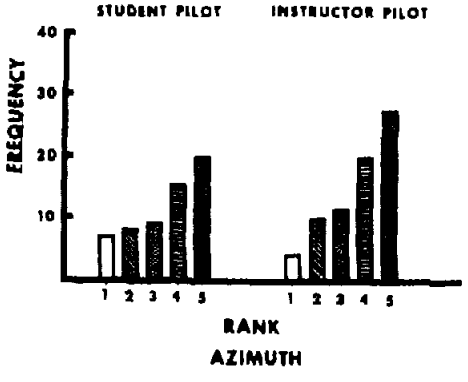
FIGURE 3

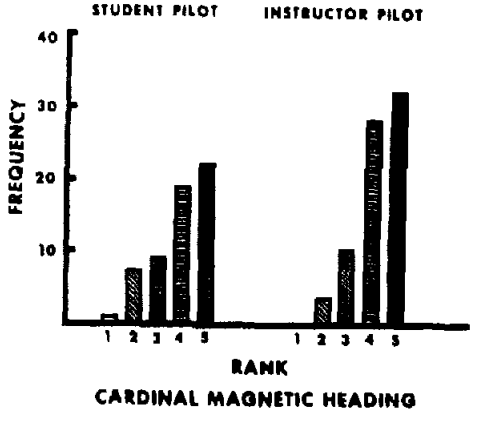
SP AND IP RANKING OF INSTRUCTIONS ACCORDING TO TIME REQUIRED FOR ACCOMPLISHMENT











The results of question nine on both questionnaires indicated that IPs had heard a student copilot use navigation terms or phrases which caused the student pilot to be confused or unsure as to what he was supposed to do significantly more often than the SPs ($X^2 = 11.85$, $df = 1$, $p < .001$). This difference correlates with the IPs greater exposure to SP navigation training.

10. If you were preparing to fly an NOE combat mission with a new pilot over unfamiliar terrain, do you think you would talk with him about navigation terms you like to use or that you are accustomed to using?

	IPs	SPs
a. Yes	94%	92%
b. No	6%	8%

IP Explanations:

10 - Different terms are used in different areas of the country
17 - No consistent terminology or common phraseology
5 - Very little time is spent on preflight instructions on the different types of terminology used in NOE, resulting in confusion between SP and copilot during flight
2 - Copilot not being specific in his directions to the pilot
3 - During the initial flight, the copilot and SP may have trouble, but it is only temporary

11. Do you have any suggestions for making NOE navigation communication more effective or efficient?

	IPs	SPs
a. Yes	54%	51%
b. No	46%	49%

12. Do you think that the IPs should give students their initial instructions on what NOE navigation terms or phrases should be used or do you feel that navigation terminology should be taught in the classroom?

	IPs	SPs
a. Yes, IPs should teach their students all they need to know about NOE navigation terminology or techniques	23%	64%

	IPs	SPs
b. No, the Aviation School should include NOE navigation terminology or techniques as a part of the classroom instruction given to the students. Then, IPs would only have to remind the students of the correct procedures during flight training.	77%	36%

Responses to question 12 were compared and the results indicated that the IPs thought that navigation terminology should be taught in the classroom first so that only problem areas would have to be discussed inflight; this position significantly contrasted with the SP opinion ($X^2 = 21.28$, df = 1, $p < .001$).

13. While flying have you ever seen poor or bad navigation terminology cause any problems? If yes, what happened?

	IPs	SPs
a. Yes	84%	59%
b. No	16%	41%

The responses to question 13 indicate that IPs have seen poor or bad navigation terminology cause problems significantly more often than SPs ($X^2 = 9.84$, df = 1, $p < .01$). This difference again could be accounted for by the IPs greater exposure to navigation training.

14. As an IP, do you have to change the terms or phrases you use for navigation when instructing NOE flight training as compared to the higher altitude flight training?

a. I use the same navigation terminology for high altitude flight as I do for NOE flight.	11%
b. I use many different navigation phrases when flying NOE as compared to high altitude flight.	33%
c. I use almost the same set of navigation terms for both NOE and high altitude flight with a few changes when flying one or the other.	56%

15. Can you see a real advantage in having formal instruction for all initial entry students on navigation terminology, therefore, having all the students "talking the same language?"

	IPs	SPs
a. Yes	77%	59%
b. No	23%	41%

Responses to question 15 again indicate that the IPs significantly differ from the SPs in that the IPs thought there would be an advantage in having formal navigation instruction, therefore, having all students "talking the same language" ($X^2 = 5.12$, df = 1, $p < .05$).

16. If you were told that you could not use terrain features at all in your navigation directions to the pilot over an NOE course, would you use: (Rank from 1 to 4. 1 = most desirable; 4 = least desirable terms).

Order of Ranking:

IP	SP
1 - Rally terms	1 - Rally terms
2 - Clock headings	2 - Clock headings
3 - Azimuths	3 - Azimuths
4 - Cardinal magnetic headings	4 - Cardinal magnetic headings

Figure 4 depicts the ranking for each type of navigation instruction.

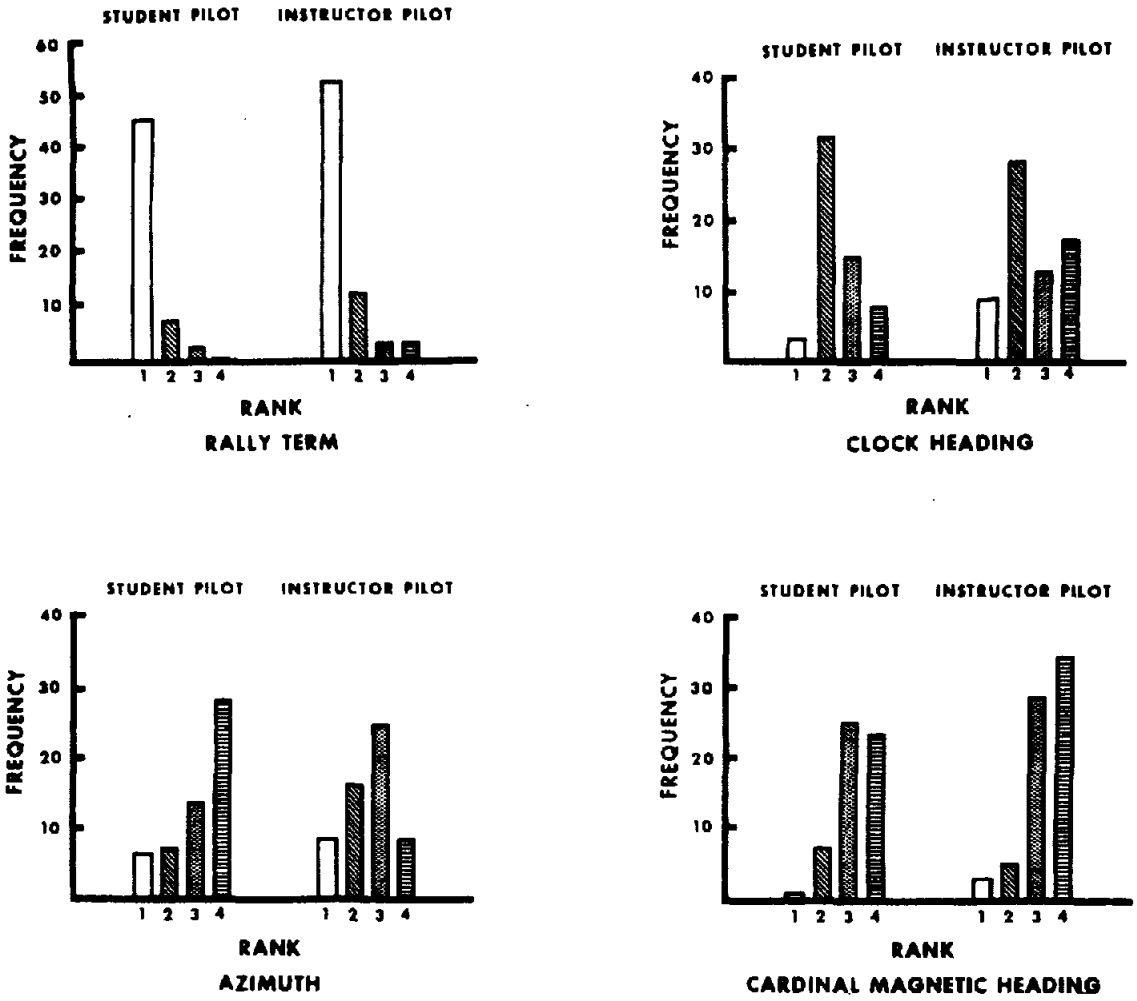
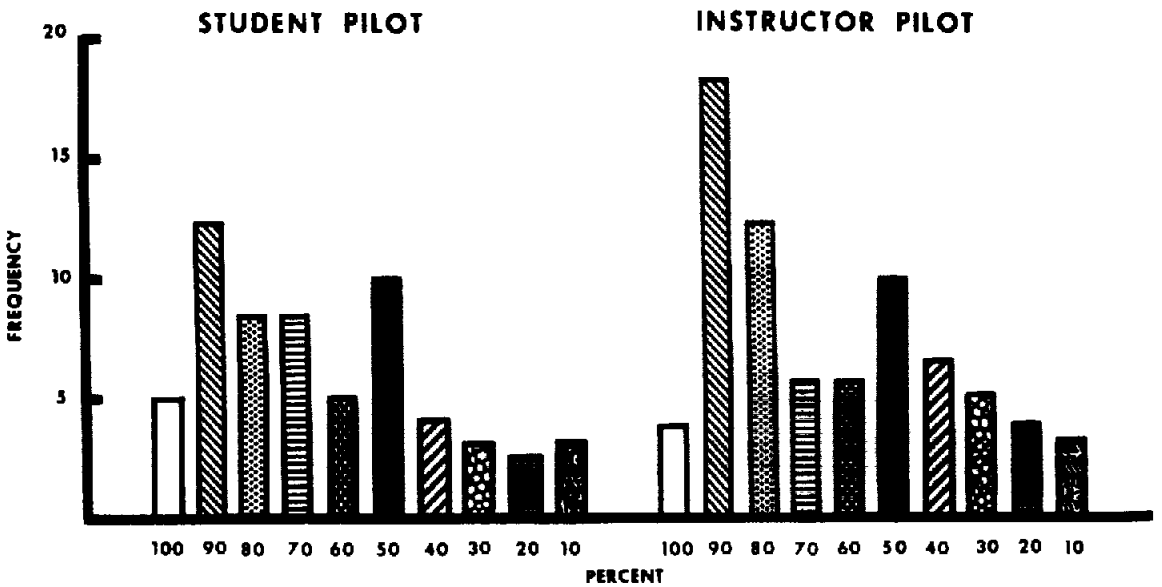


FIGURE 4

SP AND IP RANKING OF NOE INSTRUCTIONS AS TO THEIR DESIRABILITY FOR USE BY THE NAVIGATION/COPILOT

17. Approximately how much of a student pilot's (not the navigator) communication time in the cockpit during NOE training concerns navigation of the aircraft?

The responses are illustrated below in Figure 5.



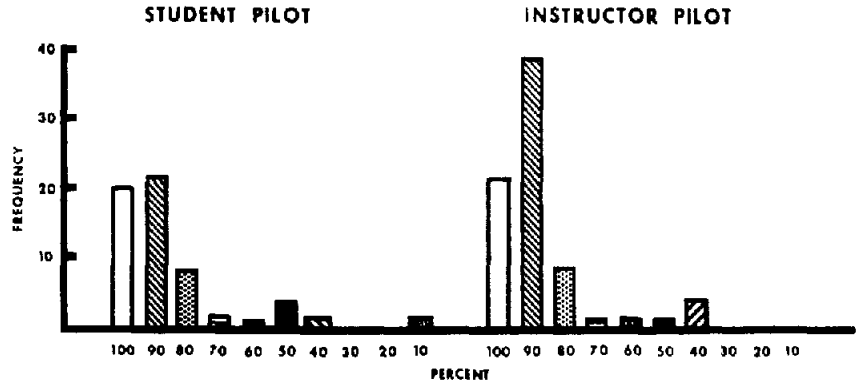
PERCENT COMMUNICATION TIME

BY THE STUDENT PILOT

FIGURE 5

18. Approximately how much of a student copilot's (navigator) communication time in the cockpit during NOE training concerns navigation of the aircraft?

The responses are illustrated below in Figure 6.



PERCENT COMMUNICATION TIME
BY THE STUDENT COPILOT/NAVIGATOR

FIGURE 6

19. Do you feel that students would get lost or off the course less during NOE training if they had a brief instruction period on NOE navigation terminology and phraseology?

	IPs	SPs
a. Yes	68%	52%
b. No	32%	48%

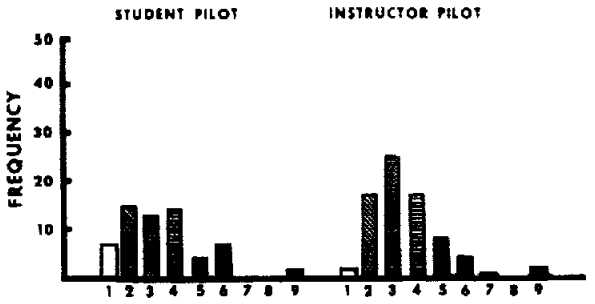
20. Do you feel that a student pilot could do a better job of handling the helicopter during NOE flight if both he and the student copilot had been given the same instructions on NOE navigation terminology?

	IPs	SPs
a. Yes	88%	71%
b. No	12%	29%

Responses to question 20 also revealed a difference in opinion between the IPs and SPs; the IPs indicated that the SPs could do a better job of handling the helicopter during NOE flight if both the SP and student copilot were given the same instructions on NOE navigation terminology ($X^2 = 9.43$, $df = 1$, $p < .01$).

21. Approximately how many times do students get lost on each NOE course run during the first stages of their NOE training?

The responses are illustrated below in Figure 7.

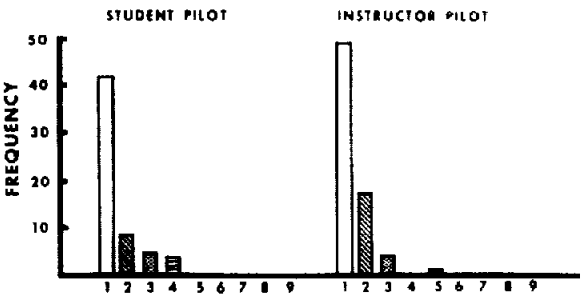


NUMBER OF TIMES LOST
DURING THE FIRST STAGES OF NOE TRAINING

FIGURE 7

22. Approximately how many times do students get lost during the last stages of their NOE training?

The responses are illustrated below in Figure 8.



NUMBER OF TIMES LOST
DURING THE LAST STAGES OF NOE TRAINING

FIGURE 8

23. Approximately how many times do students get off the course on each NOE course run during the first stages of their NOE training?

	Slightly	Severely
IPs Mean Estimate	3.2	1.6
SPs Mean Estimate	3.4	1.8

24. Approximately how many times do students get off the course on each NOE course run during the last stages of their NOE training?

	Slightly	Severely
IPs Mean Estimate	1.7	0.5
SPs Mean Estimate	1.8	1.2

25. Do you feel that students could fly the NOE courses faster if both student pilot and copilot had been given the same instructions on NOE navigation terminology?

	IPs	SPs
a. Yes	68%	65%
b. No	32%	35%

26. Have you ever had any formal instruction concerning inflight navigation terminology?

	IPs	SPs
a. Yes	29%	32%
b. No	71%	68%

If yes, who were they given by (IP, classroom instructor, etc.), and generally, what terms or phrases were you told to use?

IP Responses:

10 - Classroom instructor, terms such as: hilltop, saddle, valley (from FM 1-260).
7 - Classroom instructor, told to use rally instructions with terrain features
3 - Rally terms and clock headings
4 - IP
2 - Told to use own terminology

SP Responses:

2 - IP, azimuths and terrain features
5 - IP, rally terms (turn-stop-turn)
1 - Academics and IP, reliance on natural features and short concise instructions
1 - IP, terrain and rally terms
4 - IP, combination of terrain features, clock headings and rally turns
1 - IP, use terrain features

27. As an IP for NOE training, do you brief your students prior to flight as to which navigational features, cues, words and phrases would be best to use? Why or why not?

a. Yes 79%

b. No 21%

Reasons for Yes:
22 - Use natural features and rally terms
2 - Rally terms and clock headings
1 - Clock headings, azimuths, speeds to hold
2 - Do a good map study
1 - Use GCA type control mixed with usage of the terrain
10 - Terrain feature instruction
5 - Use terms associated with military map reading
3 - Tell them to study FM 1-260 and switch to those terms
6 - Tell them to use terms that they both understand and then give them examples of some terms and methods
1 - Rally instructions

Reasons for No:
6 - Like to see how much the students know and if they can communicate with each other
2 - Usually give instructions of this kind in the air
1 - Students should recieve their instructions inside the classroom
1 - Let students work together to develop phrases
1 - No major problems
1 - Lack of time
1 - Easier when the situation arrives

It is of interest to note that the majority of both IPs and SPs revealed that they had never received any formal instructions concerning inflight navigation terminology. However, when comparing the responses to questions 27 and 26 (SP), the number of IPs that indicated they brief their students on navigation terminology prior to flight significantly differed from the number of SPs who said that they had been briefed ($X^2 = 29.8$, df = 1, $p < .001$).

28. Do you believe that the use of topographical features as navigational aids would be safe in missions near the enemy in which your communications could be monitored?

	IPs	SPs
a. Yes	71%	55%
b. No	29%	45%

29. In a combat situation, pilots who have never flown together before are often assigned to fly together. What kinds of problems in navigational terminology and pilot-copilot communication may be encountered?

IP Responses:

14 - Misunderstanding each other in relation to terminology used
10 - Phraseology not standardized
4 - Not predictable
6 - None if they plan their flight and discuss it beforehand
5 - None if proper mission planning
2 - Misinterpretation of instructions
7 - Lack of standard terms
1 - All kinds
5 - Not very serious, only a short period of adjustment would be necessary
2 - Depends on each individual
4 - Same as in a training environment with the addition of the combat factor
2 - In a life and death situation, the outcome is usually good

SP Responses:

8 - Not very much problem, none that would not normally be encountered.
3 - Lack of communication, confusion
16 - Different terminology and meanings, reduced combat readiness
1 - Teamwork is essential

The next question was in only the IP questionnaire:

30. What is the greatest contribution you feel you can make to your student pilots during the NOE phase of their training?

4 - How to navigate effectively
4 - Teach them to believe in their maps when relating ground features and map features
2 - Teaching the students to concentrate on what they are doing with the aircraft
3 - Safe flight at NOE altitudes
3 - Confidence in themselves
1 - Make sure all instructions are understood
5 - Get him to use basic terms such as terrain features and rally directions
14 - Read and evaluate what they see on the chart as far as terrain features and also keep them out of the trees

7 - How to fly aircraft in an NOE environment, maximizing cover and concealment, also navigating effectively and accurately
13 - Teamwork and navigation
10 - Safety procedures
4 - To instill confidence
1 - TEACH!
1 - Teach pilot to anticipate navigator stop if navigator seems unsure or slows down

The following questions were in only the SP questionnaire:

31. Do you feel that you were adequately prepared in reading maps and topographical features before you were required to navigate the NOE courses?

a. Yes 75%

b. No 25%

32. During your NOE training, were there instances in which the directions by the copilot (navigator) were sufficient, but pilot error caused a deviation from the course?

a. Yes 60%

b. No 40%

33. Do you believe that more flights with the same pilot would improve or facilitate your communications?

a. Yes 95%

b. No 5%

Reasons for Yes:

11 - Being familiar with each other results in less talking to get the point across
8 - Learn a certain pattern
19 - Work more like a team, mutually agreeable method of NOE navigation commo

Reasons for No:

1 - Should know how to navigate for all pilots

34. Do you have any additional comments or suggestions concerning NOE navigation terminology or communication?

2 - Need of more ground and air schooling on navigation and map reading
1 - Rally system seems most desirable with points on horizon to navigate with
1 - Communication should not be constant flow, a signal or word to stop aircraft must be used by pilot and navigator
2 - Maintain communication, keep the pilot's head outside the cockpit
1 - Have a course in making proper map study
1 - Give the pilot ETAs to certain checkpoints
1 - Getting lost on NOE course caused by:
    a. Speed of aircraft
    b. Copilot's ability to react; exceed either one and you get lost
1 - Common terms needed
1 - Teamwork is the key

CONCLUSIONS

In general, the SPs were less consistent in their preference for certain types of NOE navigation communication phrases (rally terms, clock headings, etc.) than were the IPs. The SP responses on Question One also indicated that azimuths were one of the more desired types of NOE navigation techniques. The preference for azimuths indicates perhaps that the students do not appreciate the head-out-of-cockpit demands of NOE flight.

The IPs and SPs exhibited a very close agreement in and strong preference for terrain features or visual targets over the use of rally terms or other instructions that would point the aircraft in the right direction. The SPs exhibited a slight departure from the IPs in the type of navigation phrases they used. However, generally the IPs and SPs agreed in that they used a variety of types of instructions with the most preferred being terrain features and rally terms.

The SPs and IPs strongly agreed that they would talk over navigation terms with a new pilot before flying an NOE combat mission over unfamiliar terrain. However, the majority of the SPs thought the IPs should teach their students all they need to know about navigation terminology or techniques. If the IPs were solely responsible for navigation communication instruction, the information no doubt would not be as consistent between instructors as it would be if that material were taught from a program of instruction in the classroom. The majority of the IPs agreed that classroom presentation of NOE communication techniques would be the most desirable approach. If the same material were

presented to all aviators during flight training there would be less concern about flying with a new pilot for the first time. Also they were of the opinion that it would permit the pilot to do a better job of handling the aircraft. The IP's greater flight experience probably accounts for their choice of the formal and therefore standardized instruction which contrasted with that of the SPs. Standardized instruction dictates more uniformity of inflight communication terminology and thus a shorter reaction time in carrying out a change in course due to the expectation on the pilot's part of certain terms or phrases. A reduction of inflight confusion could result in decreased navigation communication time which would allow more time for other flight related duties. Also, a sense of teamwork and cooperation can be developed quickly between new flight members, who have had the same standardized instruction, because common understanding of navigation terminology wouldn't have to be established through experience. An analogous situation in aviation might be the terminology used by Air Traffic Controllers (ATC). This terminology is taught to all flight students so that they know how to properly ask for and respond to ATC procedures.. This has enabled pilots to interact with air traffic controllers without excessive verbiage or confusion.

When considering the workload of the student pilot and copilot during NOE training, the IPs and SPs indicated that approximately 65 percent of the pilot's communication time concerned navigation of the aircraft while approximately 86 percent of the copilot/navigator's communication concerned navigation of the aircraft. The analysis in Phase I revealed that approximately 40 percent of all NOE training time is spent in communication, therefore, the crewmembers are spending 30.1 percent of their time solely in communication concerning navigation.

The SPs and IPs agreed that students could fly the NOE courses faster if both student pilot and copilot had been given the same instructions on NOE navigation terminology. While most of the IPs and students tested were aware of the head-in-cockpit problems created by the use of azimuths and magnetic headings, far too many pilots still do not consider these types of navigation instructions to be a problem during terrain flight. Azimuths and compass headings are very effective at higher altitudes, but they are often undesirable at very low levels. Since the current IPs have been exposed primarily to higher altitude flight regimens and because no standardized navigation instruction has been developed for terrain flight, it is quite natural for them to try to continue to use what has been effective for them in the past.

The use of terrain features has been stressed by all IPs, but the navigation portion of tape recordings indicate that some uses of terrain features are more effective than others. The procedure which seemed to be most effective was for the pilot to give directions concerning terrain features within the visual field ahead. Thus, the copilot's instructions should (1) allow the pilot to fly toward some intermediate target, (2) be

only immediately useable information, and (3) therefore, not get too far ahead of the aircraft.

Many of the aviators tested indicated that they use several types of navigation terminology. For example, the copilot might use a clock heading or the number of degrees left or right of the present heading to guide the pilot toward a terrain feature which is near the desired path of flight. Thus, directing the pilot in the desired direction with rally terms, clock headings or degrees off straight ahead seems to be a very effective way of navigating when prominent terrain features are not present. This method is also useful in providing additional orientation information even when terrain features are present.

The advantages of navigation communication standardization again are realized when one considers the ambient noise levels in which the crew-members must operate. Data indicate that the pilot would be much more likely to understand (correctly identify the words or phrases) the co-pilot if the vocabulary is limited such that the pilot is expecting a finite number of possible navigation directions. Incorporation of some of the above techniques or suggestions should reduce the intracockpit communication workload, eliminate unnecessary pilot "head-in-cockpit" time, and allow the aircrew to concentrate on the more intricate elements of navigation and mission accomplishment.

REFERENCES

1. Leslie, J. M. Development of a nap-of-the-earth training program. Paper presented at the Army Aviation Training Conference and First Membership Meeting of AAAA's Fifth Army Region, San Antonio, Texas, May 1974.

2. Miller, G. A. and Lichten, W. The intelligibility of speech as a function of the context of the test materials. Journal of Experimental Psychology, 1951, 41, 329-335. Cited by E. J. McCormick, Human Factors Engineering, New York: McGraw-Hill Book Company, 1970, p. 208.

3. Ricketson, D. S. Pilot error as a cause of Army helicopter accidents. Paper presented at the Conference on Aircrew Performance in Army Aviation, Fort Rucker, Alabama, November 1973.

4. Saathoff, D. I. Initial entry and unit training requirements for nap-of-the-earth helicopter flight. Paper presented at the Conference on Aircrew Performance in Army Aviation, Fort Rucker, Alabama, November 1973.

5. Wright, R. H. and Pauley, W. P. Survey of factors influencing Army low level navigation, HumRRO Technical Report 71-10, June 1971.

APPENDIX A

Question 3.

IPs' reasons for choosing 3a:

8 - Causes less confusion between pilot and copilot.

17 - Gives the pilot a readily definable as well as visible reference.

10 - Less talking between pilot and copilot.

3 - Maintain right direction.

4 - Terrain features can be seen easily by the pilot.

2 - Decreases workload on the navigator and allows more time for tuning of radios and monitoring of instruments, etc.

2 - During NOE training, it is better to follow a creek bed rather than a given heading.

1 - Don't need to keep checking back and forth in the cockpit.

2 - Easier for the pilot to maintain ground track.

2 - Being pointed in the right direction doesn't give the pilot a feeling that he is where he should be and also requires too much dependence on the navigator.

2 - Easier for the navigator.

SPs' reasons for choosing 3a:

2 - Pilots can see features better than navigator.

7 - Allows pilot to use best terrain features to mask aircraft while moving in the right general direction.

4 - Gives a general idea of where to go.

5 - Takes the guess work out of flying.

7 - Pilot can anticipate and stay ahead of the aircraft.

3 - Limits communication and increases pilot to copilot understanding.

6 - Easier to fly and navigate this way.

3 - Gives the pilot an objective heading to alter course.

3 - Gives the copilot an opportunity for navigation time.

IPs' reasons for choosing 3b:

4 - If pointed in the right direction, the pilot can pick the best terrain and vegetation for concealment in that direction.

5 - Sometimes there are several terrain features that are the same and in close proximity to each other.

2 - Enables pilot to watch what aircraft is doing and not divide attention between navigation and what's happening around the aircraft.

1 - While being given direction to fly, the pilot would not become preoccupied with any one thing such as fence lines.

1 - Navigator should be primarily responsible for route.

SPs' reasons for choosing 3b:

5 - Clearer when concentrating on flying.

1 - Copilot has more time to watch the terrain.

1 - More dependable.

1 - Pilot and copilot sometime disagree on features they are following.

IPs' reasons for choosing a and b:

5 - Use both, assures proper flight path.

1 - Terrain features are seen easily by the pilot; however, being pointed in the right direction is an advantage when the navigator is navigating a fine point or cannot relate the terrain to the pilot adequately.

1 - Use both to produce a well-rounded student who can navigate under both situations.

Question 4.

IPs' reasons for choosing 4a:

9 - Have a better idea of where you are supposed to go.

8 - Given a target, the pilot can make minor variations in course in order to gain maximum cover and concealment and still get to the target.

7 - Pilot can be more useful in picking intermediate check points from known points.

7 - Less communication required, can go a greater distances with less instruction.

3 - Concentrate on staying outside the aircraft and on the route of flight without having to look back inside the aircraft on instructions involving navigational headings.

4 - Less confusion.

5 - Flying to a target is easier for the pilot.

1 - Ground can be covered faster.

SPs' reasons for choosing 4a:

8 - Know where the objective is and can be guided from there.

2 - More concise.

3 - Less chance of error.

5 - Allows pilot to use terrain to mask aircraft while moving in the general direction.

1 - Can use lowest terrain for a target.

4 - Can plan flight ahead, ready for turns, know to fly around objects.

3 - Have ground reference point while navigator studies the map.

IPs' reasons for choosing 4b:

3 - No confusion as to what direction to go.

1 - No chance in identifying the wrong target.

1 - Easier to follow instructions.

1 - Copilot can pick his own target.

SPs' reasons for choosing 4b:

1 - More exact.

2 - If looking ahead, the pilot may miss something in the immediate flight path.

1 - Many times no target exists.

1 - Pilot can concentrate on flying more.

IPs' reasons for choosing both a and b:

4 - With a combination of both, one can be pointed in the right direction with visual targets and kept on course with a series of turn commands.

3 - To assure both pilot and copilot are using the same visual target.

Question 5.

IPs' reasons for choosing 5a:

4 - Easier to follow creek beds than fly a clock heading; also, clock headings must be fairly constant, thus restricting maximum cover and concealment.

8 - Requires less communication, you can go a greater distance with less instruction.

10 - Lessens the confusion in the cockpit; faster progress and less communication in the cockpit.

8 - Gives the pilot a readily definable as well as visible reference (terrain feature).

9 - Clock headings aren't accurate and are confusing, clock headings are too different in individual minds.

3 - Easier for pilot to maintain ground track.

2 - Following terrain features gives you more warning on an approaching change of route.

SPs' reasons for choosing 5a:

2 - Pilot can see the terrain features better than the navigator.

1 - Easy to fly off course, keeps navigator on map.

17 - Allows pilot to use best terrain features to mask aircraft while moving in general direction.

1 - Can use the lowest terrain for target.

1 - Copilot has more time to watch terrain.

7 - Gives pilot an orientation on purpose and direction of flight.

4 - Easier, safer.

3 - Allows advanced planning and teamwork.

6 - Terrain features--clear clock headings--vary.

IPs' reasons for choosing 5b:

2 - Enables pilot to watch what aircraft is doing and not divide attention between navigation and what's happening around the aircraft.

SPs' reasons for choosing 5b:

2 - Less chance of error.

1 - Terms can be confusing.

1 - Hard to follow terrain sometimes.

IPs' reasons for choosing both a and b:

7 - Use a combination of terms, use clock headings to orient the pilot toward terrain features of concern.

Question 8.

IPs' reasons for choosing 8a:

23 - More easily understood and more accurate.

18 - Clock headings can be confusing and are not as accurate.

7 - Navigators know exactly when to tell you to roll out and can make a correction if necessary from there.

6 - Pilot doesn't have to refer to instruments, keeps his head outside.

3 - Reaction time would be less.

SPs' reasons for choosing 8a:

7 - Pilot rolls out exactly where navigator wants him to.

2 - More coordination.

8 - Less confusing.

10 - Keeps pilot's head outside the cockpit.

4 - Less time for rally instructions.

5 - More exact.

3 - Clock headings don't give enough information, perception is different.

2 - Faster reaction with rally instructions.

IPs' reasons for choosing 8b:

8 - React more quickly to clock headings, pilot has some idea at what point to check on prominent features.

SPs' reasons for choosing 8b:

2 - The pilot has an idea of where he is going so he can look ahead at the terrain.

1 - Keeps the pilot's eyes outside.

1 - Good for ball park directions.

1 - Quicker reaction.

Question 9.

The following items were listed by the IPs as having caused confusion in the cockpit:

16 - Confusion was caused by the copilot not being more specific in his directions to the pilot (also, the copilot's use of slang terms unfamiliar to the pilot).

12 - Misunderstanding of terminology due to team members being from different parts of the country.

6 - Confusion resulting from a lack of specific instructions before flight.

8 - Indistinct instructions.

4 - Generally, it is what is not said, failure to give the pilot enough information to guide him properly.

2 - Using clock headings becomes confusing to the pilot.

The following items were listed by SPs as having caused some confusion in the cockpit:

1 - Follow creek bed to the right.

1 - Stating headings (ask to repeat or turn to the wrong one).

1 - Features are confusing.

1 - Not knowing how much to turn (degree).

1 - Turn right or left.

2 - Go to the hill on the right (when there are two hills).

1 - Turn to about 3:00.

2 - Turn here.

1 - Clock headings.

1 - Navigator and pilot having different meanings for wrds.

2 - At a Y, told to follow low ground.

1 - Hold it equal to stop or slow?

1 - Keep feature to left versus fly left of it.

1 - Turn right 45^{o} and NW 45^{o}.

3 - Over there (with a hand signal).

1 - Azimuths while flying NOE.

1 - Turn to your 3:00 o'clock then to your 6:00 o'clock.

3 - Nebulous reference points.

4 - Unclear directions of approaching condition.

1 - Rally instructions without roll out direction.

Question 11.

IPs' Suggestions:

18 - Some type of standardization should be developed and initial entry students should have a class of this nature in academics.

5 - Avoid standardization, each crew should use the system which best suits that particular crew.

3 - Keep instructions simple, even if you have to talk twice as much.

3 - Have more classes on terrain features with actual pictures.

1 - Combining rally terms with terrain features would allow the pilot to maintain NOE with the least possible radio chatter.

1 - Publish a list of definitions for terrain features.

1 - Strictly adhere to terms found in FM 1-260.

2 - Use rally terms.

SPs' Suggestions:

2 - Emphasis should be placed on navigator orienting the pilot on things outside the aircraft.

4 - Copilot should be briefed as to what terms to use.

1 - Use left and right directions with azimuths.

6 - Standardization of terms.

1 - Preplan and utilize terrain and general azimuths.

3 - Proper advising of the pilot of speed and direction changes.

4 - Use familiar terms.

2 - Use terrain and rally techniques.

4 - Mutual understanding of how each navigate.

1 - Use terrain features and never use compass headings.

Question 13.

IPs' examples of navigation terminology problem areas:

7 - Confusion on the part of the SP navigator.

12 - Student pilot got lost.

13 - Navigator failed to give distinct instructions.

15 - Uncommon or different phraseology caused problems or loss of time.

8 - Pilot turned right when navigator said left.

4 - Pilot was not given full instructions on turn or route of flight.

2 - Using compass headings.

2 - The rate of turn.

SPs examples of navigation terminology problem areas:

2 - Terminology is not the problem, the problem is using hand gestures toward terrain features.

9 - Wrong instruction or vague terms.

1 - Delay in mission because of disorientation.

2 - Clock headings cause more time wasted and are more confusing.

2 - Hesitation and confusion before taking course.

1 - Speed control sometimes lacking.

2 - Poor communication resulted in (1) overshooting the LZ and getting lost and (2) confusion and flying off course.

1 - Difference in idea of 10:00 o'clock by students.

1 - Navigator failed to give a direction to turn.

1 - Poor planning.

2 - Student pilot doesn't do what you want.

2 - Lack of coordination between pilot and copilot.

1 - Copilot using "right" as a yes response.

1 - Copilot gave azimuth in area where the pilot's head needs to be out of the aircraft.

1 - "Turn 45°" - Does it mean to make a 45° turn or to turn to 045 heading?

Question 15.

IPs' reasons for Yes:

15 - Would eliminate confusion.

12 - Everyone would call out the same features in the same manner.

6 - Students would be much better for the flight line.

4 - A very brief programmed text would be fine.

4 - Would be easier to understand each other.

4 - Would simplify teaching NOE.

3 - Would be safer.

3 - Saves time, might keep students from getting lost.

1 - Would help to develop a good working relationship between students.

SPs' reasons for Yes:

5 - Standardization of terms for NOE should be set just like those for instrument communication.

7 - Creates mutual and understandable navigation phrases resulting in less confusion.

1 - Simplicity.

1 - When flying with other people you have some idea of what the other person is talking about.

1 - Better communications.

1 - Let pilots and copilots use what works best for them.

1 - No time for individual techniques unless time permits instructing the copilot.

IPs' reasons for No:

4 - Formal instructions won't change a person's communication habits.

3 - Would be a waste of time.

2 - This should be worked out before flight.

2 - If a student starts worrying about his speech, he may not be able to concentrate on his flying.

2 - It would be impossible to get everybody to use the same terminology.

1 - In order for them to understand terms, they must see the ground.

SPs' reasons for No:

2 - Has to be worked out between the pilot and navigator.

1 - Simplicity.

1 - Two people develop their own terms after one hour of flight time.

2 - Language is constantly changing and is a personalized affair.

1 - Work out terms individually with hints from the IP.

1 - Not terminology but common sense, describe what the pilot would do with a regular descriptive language.

Question 20.

IPs' reasons for Yes:

23 - Less confusing.

9 - Less hesitation when preparing to turn (reaction time would be quicker).

4 - Using the same terms.

1 - Saves training time.

1 - Better understanding and more confidence.

SPs' reasons for Yes:

9 - Prior arrangement between them would solve problems, both know what is meant by certain phrases or terms.

2 - Spend less time trying to understand each other.

3 - Eliminate confusion.

3 - Pilot could anticipate what navigator will say.

1 - But experience teaches.

4 - Communication with the copilot is worked out easily, everyone develops methods anyway.

1 - If navigator is unsure of his location, hesitation exists regardless of phraseology.

3 - Communication takes practice.

3 - Navigation principles are more important.

IPs' reasons for No:

2 - Doesn't warrant a classroom course.

2 - Students should develop their own phrases.

2 - Landing the aircraft has little or nothing to do with navigation terminology.

3 - Communication habits won't be easily changed.

Question 28.

IPs' reasons for Yes:

1 - I feel terrain features would be hard to recognize.

4 - (Depending on local area terrain) - Just by using terrain features it would be virtually impossible to pick out a route of flight.

11 - It's a sure bet that "they" could be laying for you at the prominent topographical features.

4 - Once you explain terrain features you see on the ground, someone could perhaps locate you on their map.

1 - Provided you didn't transmit.

1 - Only permanent features on the earth--other methods can be rendered unusable.

SPs' reasons for Yes:

6 - Don't pinpoint location by communicating the general location.

2 - Since intercom is used.

5 - Safe in area with relatively uniform terrain, unsafe with unique terrain.

1 - More important to know where you are.

1 - As long as radio silence is maintained.

3 - If you use a code.

IPs' reasons for No:

4 - Who has equipment to monitor intercom consistently?

3 - Topographical features would normally be alright, however, they tend to change due to artillery bombs, strikes, etc.

SPs' reasons for No:

9 - Enemy would know your position.

1 - Careful use of terms would avoid this.

1 - Silence is imperative.